Advanced Control and Optimization Solution for Dynamic Control of SCR Systems

Neel J. Parikh
Pegasus Technologies, Inc., 5970 Heisley Road, Suite 300, Mentor, OH 44060-1872
Email: nparikh@pegasustec.com; Telephone: (440) 357-7794; Fax: (440) 357-1119

Jim Donegan
Pegasus Technologies, Inc., 5970 Heisley Road, Suite 300, Mentor, OH 44060-1872
Email: jdonegan@pegasustec.com; Telephone: (440) 357-7794; Fax: (440) 357-1119

Summary

In response to EPA's State Implementation Plan Call Rule, in excess of 100,000 MW and up to 150,000 MW of US coal fired plants are being retrofitted with SCR systems. The rule necessitates an overall annual reduction of around 958,000 tons of NOx and an average NOx emission of 0.15 lbs/MMBtu. To achieve this level of NOx reduction, Utility's specification for SCR system for a given coal, inlet NOx concentration and load range, calls for, % NOx removal efficiency, catalyst life, NH3 slip, SO2 to SO3 conversion, maximum pressure drop across the SCR reactor, and gas velocity, temperature and ammonia distribution. All these parameters are influenced not only by the SCR process but also by the boiler performance and unit heat rate. NOx reduction for a given inlet NOx concentration and ammonia distribution, is mainly dictated by the coal/ash chemistry, sulfur content (particularly for bituminous coal), conversion of SO2 to SO3, (function of excess air and temperature), ammonium sulfate/bi-sulfate formation, arsenic, calcium (sulfate formation particularly from PRB coal), sodium and magnesium (sulfate formation).

The Pegasus Optimization Suite is based on artificial intelligence, adaptive neural networks, advanced control and optimization technologies. The software measures critical process parameters and optimizes the Unit performance or other desired objectives in a supervisory, closed-loop control mode. The system is setup to dynamically adjust optimal biases or setpoints based on the current Unit operating conditions and the desired objectives. The main objectives of a successful SCR Unit operation for a specified NOx removal are maximization of the catalyst life and minimization of ammonia slip and airheater deposits/corrosion.

NOx emission is a function of a number of variables which include: furnace design, combustion temperature, residence time, burner stoichiometry, over fire air (OFA) design and operation, coal/air distribution, excess air, nitrogen content of coal and particle size. Boiler performance optimization involves a critical real time review of each of these variables to achieve maximum overall benefit for the unit.

At a given load level, improvement in heat rate due to combustion optimization reduces the fuel requirement. This reduces the inlet NOx concentration and the quantity of flyash to the catalyst chamber. Combustion optimization may lower excess air and furnace exit gas temperature, which helps to reduce the conversion of SO2 to SO3. Lower NOx and SO3, reduce the ammonia requirement and propensity of formation of ammonium and calcium compounds respectively. Consequently, the catalyst pore blockage is curtailed, thereby improving catalyst life. Lower SO3 also reduces airheater corrosion and deposit formation and thus improves its performance. The net result is maximization of the SCR performance at a minimum O & M cost.

Conventional SCR Control Systems rely on a simple feed-forward loop (with feedback trim) based on stack NOx emissions and experimentally derived NOx versus load curves for ammonia injection. This does not lead to efficient control since NOx emission is only one function of the unit load. Other variables such as excess air, OFA damper positions, burner stoichiometry etc. have a significant effect on NOx formation. Delay in the NOx signal from the stack causes inaccuracies in ammonia injection, which leads to poor control, excess reagent usage and high ammonia slip. High ammonia usage increases ammonium sulfate/bisulfate formation and their deposition on the active sites reduces catalyst life.

Pegasus' artificial intelligence based software improves boiler performance and NOx control. Neural networks are universal function approximators. A neural net can represent any physical model. These models can easily be devised from test data, historical data or a combination of the two. The models allow one to trade off multiple objectives such as NOx reduction and heat rate improvement, while maintaining other plant parameters such as steam temperatures, LOI and CO within desired constraints. The software can be applied to optimize the performance of an SCR.

An annual savings of over $525,000 can be estimated for a 500 MW coal fired unit with an SCR controlling NOx to 0.15LBS/MMBtu based on a 50 Btu/kWh improvement in heat rate and 15% reduction in baseline inlet NOx emission.

For more information regarding Optimization Solutions from Pegasus, visit www.pegasustec.com or contact Pegasus Technologies at (888) 357-7794.